SUBMARINE ESCAPE HISTORY

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CHAPTER XIII

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The following notes concern sinkings of submarines from which survivors have been able to report possible and definite causes of the disasters and which seem to stress the importance of escape training in peacetime and war. The report includes case histories of the sinkings of submarines of various nations, and provides much information on escape procedures used by these countries.

GERMAN SUBMARINE U-3

Sank in dock in Kiel (pre 1914). The crew failed to close the after hatch and 25 men were trapped in the torpedo room. She was a very small submarine and cranes were able to lift the bow and the men were released.

AMERICAN SUBMARINE O-5

Sank in Coco Solo Canal zone in shallow water; she was a very small submarine and floating cranes raised the fore end and two men were rescued after 36 hours.

DANISH SUBMARINE DYKKEREN

She was a small submarine of 150 tons and was rammed by a steamer and sank in 28 feet of water off Copenhagen in November 1916. The bulkhead abaft the conning tower was closed leaving nine men alive forward. Only six had Draeger breathing apparatus available. The Commanding Officer decided to go into the conning tower with three men and help them escape by the conning tower hatch. These three men used their Draeger gear and escaped successfully. The Commanding Officer, however, was not successful in shutting the hatch and perished. It is probable that he failed to work his oxygen valve properly and became unconscious, as later when his body was recovered his oxygen was full. The remaining five men went into the torpedo room while this escape was going on. Water gradually entered the torpedo room and the storage battery, forming chlorine gas. By using the spare potash regenerators of the Draeger gear they did not suffer very much from chlorine.

Salvage vessels arrived and a diver made contact by acoustic morse signals. After conferring with the three men who had escaped successfully the amount of damage could be assessed and it was decided to hoist the bow to the surface by means of salvage craft. Approximately four hours after the accident air connections were made and air at atmospheric pressure was passed to the men imprisoned in the fore compartment, which greatly helped their survival. Nine hours after the collision the bow was hoisted above water and the five men released.

E-41

Rammed by E-4. 8th August, 1916 off Harwich. Depth of water 45 feet.

When E-41 was hit an attempt was made to close the forward bulkhead door, but the water was rising rapidly and everyone was ordered on deck. While the men were still going up, the boat sank by the bows. The rising air pressure blew open the upper conning tower hatch and carried two sublieutenants to the surface. The FIREDRAKE, hurrying to the spot, was able to pick up only three officers and eleven men. One and a half hours later another survivor, Stoker Petty Officer Brown came to the surface. The story of his escape is a tale of indomitable courage in the face of difficulty.

As the boat was sinking he tried to close the lower conning tower hatch, but water was coming through it and he had to retire aft. He could find no one else alive and found himself alone in the engine room of the sunken submarine, dimly lit by a single pilot lamp. His only hope of escape was by the torpedo hatch, and with water rising round him, he started to disconnect its gearing and unship its strongback. Twice or thrice he had to dive under water to work the wheel of the gearing, and received several severe shocks from the switch

board. The water rose steadily, the air pressure increased, but his most strenuous efforts only succeeded in opening the hatch half way. For close to an hour he wrestled with it and thrice it flew open, releasing a portion of the precious air, but the pressure was not sufficient and it closed grimly on him crushing his hand badly before he could escape. In poisonous fumes, with only one hand and in the face of failures, he refused to give up hope and, as a last resource, decided to flood the boat as quickly as possible. Opening a deadlight in the bulkhead he allowed the engine room to flood completely. With the water right up to the coaming of the hatch he knocked out his pin. "I then raised the hatch and escaped" he wrote. He rose 40 ft. to the surface and was

GERMAN SUBMARINE U-51

picked up by the FIREDRAKE after a desperate but never despairing struggle for an hour and a half.

On 14th July 1916 U-51 was torpedoed and sank off the Jade in approximately 90 feet of water. She sank down stern first in 10 to 15 seconds. The torpedo hit between the central compartment and the engine room. All the men in these compartments and on the bridge were killd by the explosion.

As dinner was being served a large number of the crew were [illegible] in the crew space. The bulkheads had been closed, water entered the living quarters immediately and the men retreated into the bow compartment. Among them was the Commanding Officer. Emergency lamps were taken. 18 men thus collected in the forward compartment.

It was now discovered that 6 of the 18 had no Draeger gear. For this reason it appears that the Commanding Officer decided not to make any attempt to get out (it is thought that both he and the Chief Engineer, who was also forward, had been dazed by the actual explosion of the torpedo).

After about 4 hours the air began to get very foul and the Draeger gear was used to breathe from. Before long, however, this gave out and the conditions became very bad indeed. When nearly all the men were dying, two men decided to make an attempt to escape. It is not known how these men actually made their escape, but it must be presumed that they equalized the pressure either by flooding or releasing H. P. air or a combination of both. Both got out and reached the surface, but one was already dead. This was approximately 10 hours after the boat sank.

When the submarine sank 3 men were also left alive in the after compartment. The after hatch had been slightly bent by the force of the explosion and they were unable to make an immediate escape. One of these 3 men was very dazed and in a weakened condition. Finally, 50 hours after the accident these three men escaped, presumably by flooding the compartment. All wore their Draeger gear; two arrived on the surface not only alive but in apparently good condition; the third man was assisted towards the surface but apparently died on the way up as they had to let him go during the ascent and he was never seen again.

K-13

Sank in the Garelock in 60 feet of water in January 1917, due to the engine room ventilators being left open. Thirty-two men in the after part of the submarine were instantly drowned. Forty-eight others were alive in the fore part. The Captain of the submarine, Commander G. Herbert, went into the conning tower with Commander F. H. M. Goodhart who was afterwards killed during the ascent by hitting his head on the chart house roof. Goodhart was the Captain of another K boat and was taking a trip with K-13. They intended flooding the conning tower to allow Goodhart to escape and so inform those on the surface of the situation below. Herbert was to remain and shut the hatch after Goodhart left. Compressed air was used to equalize the pressure. Commander Herbert describes the escape as follows:—

"During the night we heard sounds as if someone was trying to locate the ship with a grapnel and at about 6 or 7 a. m. we reported to the divers tapping, but could get no sense with the Morse Code. During the forenoon I

asked Commander Goodhart if he would try and get out at low water, 12:30 p. m., with the necessary instructions to those on top for giving us air and food.

Accordingly, after thinking things out, Commander Goodhart decided to try for it and I agreed that I should try and close the door after him. I arranged a code of signals to Lt. Singer in order that he could drain down the conning tower after Commander Goodhart had gone clear.

Commander Goodhart and I worked all forenoon taking away the projector compass to give headroom and also in connecting an H. P. valve to the whistle pipe to act as a blow. When everything was ready I charged the conning tower with air to make sure the bottom door and glands through which electric cables passed were tight. After rectifying this, which took roughly an hour, we were ready.

A small tin cylinder about 8" by 1½" was then filled with instructions to the people on the surface and Commander Goodhart, putting this in his belt, proceeded into the conning tower with me. His last words were "Well if I don't get up the cylinder will". He opened the flooding valve (fuel vent disconnected) and when the water rose to our waists I turned on the H. P. air. Commander Goodhart knocked off the clips of the conning tower. The conning tower lid began to let water in and was soon wide open. Commander Goodhart stood up in the dome, took a deep breath, and then made his escape. We were both exceedingly out of breath at the time. Almost immediately I put my hands up to feel for the lid without knowing found myself carried through the opening into the shelter, the roof of which must have struck my head from the bruises and a cut I subsequently discovered.

All the time H. P. air was escaping fast from the conning tower and I attribute my escape entirely to this, for without doing anything I found myself shooting through the square hatch in the top of the wheel house. I breathed hard all the way to the surface and fortunately arrived up between two craft one of which hauled me aboard".

Herbert came up 23 hours after the submarine sank. From Herbert's report and knowledge of the boat the divers were enabled to connect up H. P. air (another submarine supplied the air (E-50)) and by this means the survivors in the boat blew out some tanks. This extra buoyancy, plus large wires which were passed under the bows allowed salvage craft to get the bows to the surface and a hole was cut in the hull and the survivors escaped 54 hours after the disaster.

Foul air might have killed them before this, had not the divers connected a 4" flexible pipe to the ammunition hand up. This was approximately 40 hours after the accident. A divers air pipe was passed down this 4" pipe for refreshing the air inside.

There are two particular points of interest, one is that the survivors were saved by air being passed to them and that Herbert discribes in two different reports written shortly after his escape that "I breathed hard all the way to the surface" and again "swimming vigorously for the surface, I was compelled to place my hands over my face and take a deep breath which to my surprise was air and not water. Shortly after this I broke surface." It is probable that Herbert's experience was the excess pressure in his lungs exhausting itself on the way up. Nothing of course was known of excess pressure in those days. It is possible that there was so much H. P. air exhausting from the conning tower that he was actually coming up in a large air bubble or air stream.

U B-57

She struck a mine off Dover in the 1914-18 war and sank in 128 feet of water. The boat flooded rapidly aft filling up to the forward C. R. bulkhead. The forward bulkhead leaked badly. Twenty men were alive in the forward compartments. It was decided to distribute eight of these men in the conning tower and the remainder under the fore hatch. Only four Draeger breathing apparatus were available.

They first attempted to equalize the pressure in the boat by using H. P. air from the bottles and torpedoes, but this proved insufficient and they had to flood the boat in addition.

It was not until approximately 1½ hours after the accident that they succeeded in equalizing the pressure and opening the batches.

The flooding up period was terrible, chlorine gas caused bad caughing and the constantly increasing difficulty in breathing with aching pain in the ears made conditions well nigh unberable. Two men could not stand it any longer and shot themselves. The Officer in charge contemplated taking morphine and the following is this officer's story of his escape:—

"The water was in the boat at a height of about one foot above the floor plates, when I once more tried to open the hatchway. Suddenly against my expectation by the increasing inside pressure the hatchway cover was torn out of my hands and flung open. I just could shout "Hold on" and then was lifted without any effort on my part out of the hatchway and remained for just a short moment up to the hips out of the hatchway cover without getting wet. I stood in front of a dark black greenish wall, through which the outlines of the conning tower were perceptible. Then the water broke all over me and I commensed to rise. To previously inhale deeply had been impossible for me due to the difficulty of breathing and the exertion while trying to open the hatchway cover. For that reason I had not inflated the life-belt and only closed its valve, so that no water might get into it. While rising I had the sensation to constantly increase in size. I was curious to see how long I would be able to hold my breath and was astonished to observe that I had no desire to inhale but to forcibly exhale so that I constantly had to blow air out of my cheeks. (Looking upon what had happened an easily understandable case, because I had air at 3.5 atm overpressure in my lungs which while rising expanded gradually). I therefore commenced to stop my trip to the surface by energetically moving my hands. How long it took until I came to the surface I do not know and it has been impossible for me to even guess at that length of time. No. 2 of the queue leaving the conning tower at any event had arrived at the surface of the water before me and within about two seconds more, all of the eight men had been shot out of the conning tower hatchway like corks out of a bottle. A short time later the men from the fore compartment eppeared. Of these some, after a terrible scream, went down again. This I explain by the fact that their bodies were internally bursted (by holding their breath). My surprise was great when at the surface my swimming vest was filled with air to the point of bursting. (Reasoning out what had happened, a very simple case, exactly the same conditions influencing my lungs). From one of the men saved I heard that the crew in the fore compartment had seen in the rising of the manometer an indication of the boat rising to the surface and had commenced to hastily pack their clothing. When the manometer showed 6 meters they thought that the boat had come to the surface and opened the hatchway cover through which - very much to their surprise - the water heavily rusher in. I was told by him that he had been in the compartment fore, quite a distance from the hatchway cover, and had to swim through the boat to the hatchway leaving her as the last man.

On the surface we first tried to make our way for a buoy which, however, we missed by drifting away from it. Through a light swell running it was impossible to see the other men. We tried to keep together by shouting at each other. My watch Officer who against my advice had undressed entirely after some time did not reply any more and no doubt was benumbed (heart-failure). The water had a temperature of about 4° Celsius. I myself left in the boat only my sea-boots, cap and gloves, so that I did wear what during cold weather one has of clothing on board of a submarine. After some time the masts and the funnel of a guard-ship came in sight. By jumping out of the water and clapping with the hands I indicated to her our location. I was picked up by her already unconscious with six others amongst them the Chief Engineer. How it came about that I became unconscious I do not know. I only remember without any struggle or fear of death. I only know that with my

clothing thoroughly soaked I had to swim hard notwithstanding the lift-belt in order to remain floating.

My Chief Engineer was lifted on board by the guard ship as the first man. She lowered a boat and made a search for about an hour and twice picked up each time three men. During their second trip they found me as the last one with my head already in the water. The Chief engineer was likewise unconscious and could not be revived. We did swim in the water about an hour to an hour and a half".

POSEIDON

Rammed and sunk off Wei Hai Wei by S. S. YUTA at 1212 on 9th June 1931 in 130 feet of water. 18 men trapped in the after part who perished. Of the remainder 27 left the submarine by the conning tower before she sank and 8 were trapped in the fore ends. Of these 5 made successful escapes, 1 died making his escape and 2 never came up.

The tube space and stowage compartment were flooded by means of No. 3 bowcap, draining to the main line and into the compartment by the W. R. T. suction. Pressure was equalized after 2½ hours when two men escaped through the fore hatch, wherupon it shut again. Of these two, one came up with his mouthpiece cock shut, and was dead on reaching the surface. Death was diagnosed as a burst lung although no autopsy took place. The other used his D.S.E.A. nearly correctly, but the exhaust valve clip was removed too soon resulting in a serious loss of oxygen. In addition, his nose clip was knocked off on leaving the submarine. This man suffered no ill effects although he lost consciousness whilst supporting the dead man on the surface. On the way up he states that he kicked and swam in order to speed up the ascent at the beginning (presumably he started off negatively buoyant) and exhaled through his nose during the latter part of the ascent.

The compartment was flooded up again by the remaining 6 men and 3¼ hours after the disaster the pressure equalized again and 4 men managed to escape.

The first came up using his D.S.E.A. solely as a buoyancy bag, full of air, with the mouthpiece cock shut and the exhaust clip on, his oxygen having run out. This (P. O. Willis) gave the following account of his escape:

"The hatch then flew open and the compartment was immediately filled. I seemed to hang around the hatch for a few seconds and then seemed to shoot up, having very violent pains in the chest at the same time. A short time after getting out I opened my mouth; I could not stick it any longer. The pain eased and I went unconscious. I came to in the stern sheets of one of the cutters". He afterwards had no ill effects.

The next two men (one a Chinese boy) came up without removing the exhaust valve clip at all, resulting in slight caisson disease in the case of the Chinese boy and no ill effects in the case of the other man. Nose clips were in place and there was no escape of gas at the mouthpiece.

The fourth man came up having used all his oxygen. Just before leaving he broke the small emergency oxylet. He came up with the mouthpiece in and the exhaust valve clip off, but suffered from severe caisson disease. He felt no symptons until he reached the surface and boarded a boat. He then "went paralysed and had shooting pains in all his joints".

Of the two who never came up (one a Chinese boy), one had a set but no oxygen and is presumed to have drowned on leaving the hatch. The Chinese had no set and is presumed to have drowned in the compartment.

U. S. S. SQUALUS

Sank on May 23rd 1939 in 220 feet of water. Temperature of water 29° F. at about 0840.

At 1040 May 23rd, it was noted that SQUALUS' expected surfacing report was one hour overdue. Submarine SCULPIN was ordered to try and

contact SQUALUS. FALCON, Submarine Salvage Ship, was also warned at this time to be ready to stand by.

At 1241 SCULPIN reported having sighted a red smoke bomb from SQUALUS. Later SCULPIN reported locating the marked buoy from the SQUALUS lat. 42° 53' N. long. 70° 37' W. This position was 3¾ miles westward from the reported diving position of SQUALUS. This fact is pointed out in order to emphasize the extreme value of the alert lookout kept by SCULPIN, and undoubtedly saved a tremendous amount of time which would otherwise have been expended in searching for SQUALUS.

The Commanding Officer of SCULPIN reported that he had picked up the marker buoy, which was the forward one of the SQUALUS and had held two minutes conversation over the buoy telephone with Lieut. J. C. Nickols and Lieut. O. F. Naquin, Commanding Officer of SQUALUS which was in substance as follows:—

Wilkin "What is your trouble"?

Nichols "High induction open, crew's compartment, forward and after engine rooms flooded. Not sure about after torpedo room but could not establish communication with that compartment. Hold 'phone and I will put you on to the Captain".

Wilkin "How are things"?

Naquin "Consider best method to employ is to send diver down as soon as possible to close high induction and then hook on salvage lines to flooded compartments and free them of water in attempt to bring her up; for the present consider that preferable to sending personnel up with lung".

At this point marker buoy cable parted. Later investigation showed that a blight of the bouy cable had been caught on some sharp obstruction over the side of the SQUALUS.

SCULPIN then located SQUALUS with her supersonic equipment.

At 1930 PENACOOK hooked her drag anchors on to SQUALUS.

At 1245 a U. S. Coast Guard Vessel arrived bringing experts of the Experimental Diving Unit who had been sent by air from Washington, D. C.

No attempt was made to conduct diving operations during the night. It had been ascertained that the personnel in the forward compartments of SQUALUS were in no immediate danger. Satisfactory communications had been established with the SQUALUS since 1345 by tapping in morse code on hull of SCULPIN and hearing similar messages from SQUALUS. Early messages indicated 33 men alive in forward part of the ship. Conditions were reported satisfactory but cold.

On May 24th at 0415 Commander Allan R. McCann, U.S.N. and 12 divers of the Experimental Diving Unit arrived at the scene of operations.

At 0425 U. S. S. FALCON arrived. Divers from FALCON were sent to SCULPIN to familiarise themselves with the layout and equipment to be found on the SQUALUS, which is a sister ship.

FALCON, owing to wind and sea conditions, had some difficulty in getting into the right position but at 1014 the first diver went down and reached SQUALUS at 1017. The descending line used was the buoy line which had been attached to the drag anchor by PENACOOK and this line was discovered by the diver to be only 6 feet aft of the forward torpedo room hatch.

At 1028 the rescue chamber downhaul wire was shackled to the desending line and lowered to the diver who shackled it to the hatch at 1039.

The extremely skilful work of this first diver resulted in marked evpedition of the whole rescue operation and contributed greatly to its ultimate success. In addition to shackling on the the downhaul wire it was necessary for him to clear the bight of the marked buoy line, which lay across the hatch, and was still fouled somewhere over the side. Had this buoy been allowed to

remain, it would have endangered rescue chamber operations by possibly fouling or preventing a tight seal on the hatch. The rescue chamber was hoisted over the side for the first trip at 1130 and reported on the submarine at 1212. The operators reported the SQUALUS to have a 7° list and to be down by the stern.

At 1240 the chamber had been securely attached to the submarine and the upper hatch opened. The lower hatch was opened and contact estblished with the submarine crew at 1247.

Provisions and dehydrating materials were delivered to the crew, the submarine was ventilated through the chamber for several minutes, and seven passengers taken on board.

At 1256 the submarine hatch was closed.

At 1342 the rescue chamber reached the surface and survivors evacuated.

The first three rescue trips were made expeditiously, and equipment functioned as designed throughout these trips. This was the first occasion in which the rescue chamber had been used for other than training purposes, and the results achieved have fully justified the vision, faith and hard work of those involved in the development of the equipment.

The fourth trip of the rescue chamber proceeded apparently according to schedule up to 2022 when during the ascent with the last survivors on board, the air motor which drives the downhaul equipment stalled and could not be restarted. An attempt was made to continue the ascent by controlling with the brake instead of the motor, but at 155 feet level the reel again jammed and no further downhaul wire could be let out, even with the brake released. The downhaul equipment could not be moved either up or down, therefore the decision was made to lower the chamber to the bottom and send a diver down to unshackle or cut the downhaul wire to free the chamber.

At 2122 the downhaul cable was cut by a diver. An attempt was immediately made to heave up the chamber with the winch but the strain on the retriever wire was abnormaily heavy and at 2125, the retriever cable stranded. The strain was quickly taken off and the chamber lowered to the bottom. After a conference it was decided that the best method of getting the chamber up would be to adjust the buoyancy of the chamber as nearly as possible to neutral on the negative side and then haul in the frayed retrieving wire carefully by hand in order not to part the remaining strand. In using this method, the danger of acquiring postive buoyancy of the chamber with resultant swift ascent to the surface, and the possibility of its coming up under the FALCON had to be accepted. This method was entirely successful and the chamber surfaced and the last known survivors were evacuated at 0025 May 25th.

It was now decided to make a trip in the chamber to the hatch communicating with the after torpedo room in order to be absolutely certain that there were not survivors remaining in the SQUALUS. FALCON therefore changed mooring and after a new downhaul cable had been fitted the chamber commenced its last descent at 1719. It was necessary in this operation to equalize the pressure in the rescue chamber with that of the sea in order to enable the submarine hatch to be opened without flooding the chamber. At 1715 the rescue reached the submarine. When the after torpedo room hatch was cracked water commenced to flood into the chamber from the torpedo room proving that this torpedo room was flooded. The hatch was secured and the rescue chamber started to ascend and at 2107 was landed on the deck of the FALCON. It shall be noted that in the final operation the two men in charge of the rescue chamber were in some danger. If they had become incapacited for any reason there was no way in which they could have been rescued, as the chamber could not be entered from the outside.

Remarks:—

With the exception of the last rescue trip of the chamber, when the downhaul wire became jammed, each trip of the chamber to the submarine and back to the surface took approximately 2 hours and 15 minutes.

The last survivors reached the surface at 0025 on May 25th. The SQUALUS sank at 0840 May 23rd, so that these survivors were submerged for a total of 39 hours and 45 minutes.

All survivors complained bitterly of the cold in the submarine while waiting to escape. The water temperature was 31° F. and the compartment air temperature was only 36° F. The air in the compartment was foul with C.O.2 but this could never have reached a very high level as this air was refreshed with each trip of the chamber. Chlorine was just beginning to make its presence felt when the last survivors were taken aboard the rescue chambr.

H. M. S. THETIS

She sank off Liverpool on trials in June 1939 in a depth of 120 feet as the result of the rear door of a torpedo tube being opened under water with the bow cap open.

Due to the unfortunate fact that the W/T door on No. 25 bulkhead had clips and butterfly nuts instead of being quick closing, they were unable to close it quickly enough to prevent further flooding. Had this door been quickly and securely shut the submarine could have been brought to the surface by the crew's own efforts.

Both fore end and torpedo stowage compartment flooded, i. e. all compartment forward of No. 40 bulkhead.

With the crew and trials party there were no less than 103 people left alive in the remaining parts of the submarine.

It was first decided to pass into the flooded part of the submarine for purposes of shutting the tube and so pumping out, using the escape chamber as an air lock. An officer first went in alone with a D.S.E.A. set, but was unable to stand the pressure. A second attempt was made by a different officer and a P. O. They practically reached the full sea pressure (120 feet) but as the P. O. complained about his ear hurting the attempt was abandoned. This same officer went in again with another P. O. but the second P. O. showed signs of distress as the pressure was built up and the attempt was again abandoned. The officer at no time suffered unduly except from the cold water.

There is no doubt that this incident was most unfortunate as it must have had an adverse effect on the survivors, making them lose confidence in a normal escape from the chamber at this depth.

A great deal of work was done in the submarine during the night with the subsquent building up of C.O.2 with the large numbers in the confined space remaining and breathing fast was already noticed ten hours after the accident. After 14 hours some men, who had been working, began to feel sick.

After 17 hours the crew had lightened the submarine aft sufficiently to get the stern up, but by that time most people had headaches and were breathing fast.

The angle of the boat, once the stern was up, was severe and, in order to get aft, men had literally to haul themselves up. This extra strain on men already distressed by the C.O.2 can be appreciated. For example, one officer stated at this time that by the time he got aft he had to rest for 10 to 15 minutes before having enough energy to don a D.S.E.A. set. 18½ hours after the accident breathing was becoming increasingly difficult and the older men were in a bad way.

Two officers then went into the after escape chamber and made their escape without any real difficulty. The after chamber was about 10 feet below the surface at that time. They both used D.S.E.A.

After this successful escape the chamber was drained down, but unfortunately the water, due to the angle, drained into the main motors and

started an electrical fire with masses of smoke. The effect of this on the already foul air can be appreciated.

It must have appeared now to the survivors that unless they made hurried escapes most of them would be unable to escape at all due to the C.O.2 content in the air. It was probably this fact that decided them to make the fatal mistake of putting four people in at once in a chamber designed for two. They were flooded up, but either they got jammed or panicked, for after a quarter of an hour they were still in the flooded chamber; the hatch was shut, and the men pulled out. Three were dead and the fourth nearly so. (All four had D.S.E.A. sets).

Two were sent in after this, one of whom was a civilian who had never used D.S.E.A. before. These two men made their escape with D.S.E.A. sets in the normal manner without any great difficulty; the after chamber still being only about 10 feet below the surface. No one else ever came out.

There is little doubt that after the last two left the remained were in too bad a state, due to foul air, to be any longer capable of making the physical effort of the escape.

After the boat had been salved and the submarine under water for nearly three months, the escape chamber mechanism was still in perfect working order.

There is every reason to suppose that had the normal routine escape made earlier enough before the air became foul, a large majority would have reached the surface successfully.

The lack of a ready means of supplying air at atmospheric pressure was also a disaster. Had the crew removed the manhole to Z tank which was secured by bolts to the after compartment bulkhead and run the compressor once the stern was on the surface, they could themselves have obtained air through Z vent which was above water, but by this time approximately 18 hours after the disaster, they were too overcome by the C.O.2 to think or reason clearly.

U-40

Hit a mine off Dover in mid-October 1939 and sank in 115 ft of water. The two forward compartments were immediately flooded and everyone in them drowned. Nine men were left alive in the after compartment. They were left in darkness, but used torches. There was no officer who survived.

The men discussed when to escape and decided to do so an hour after she sank. One survivor stated the air was getting foul, but the others did not confirm this. Some ate biscuits while waiting, some nothing. Some put on a lot of clothes, some had only a suit of underclothes. There was no panic, a certain amount of good humor and no tendency to blame anyone for the disaster. Valves were opened and the compartment took 10-15 minutes to flood. The men took precautions not to be knocked over by the inrush of water when the hatch spring was released. The 9 men escaped in between 3 and 4 minutes. They did not use their pressure release stopcocks but allowed the surplus oxygen to escape out of their mouths as they ascended. The 9 men reached the surface but one was missed fairly soon and no reason could be given for his disappearance. The remainder complained bitterly of the cold. All of them had on life-belts which they inflated by blowing them up when they were in the water. Four men huddled together in the water for warmth but after a few hours exposure one after the other died until only Weber was left. Five men lost their lives through exposure. The three survivors think that this was due to cold but is was probably accelerated by the inhalation of water as the three survivors were intensely thirsty in hospital. One states that, just at dawn, a small boat passed near him but his cries were not heard. He lost his courage and the cold was so unbearable that he deflated his lifebelt with a view to drowning. He found the sensation so unpleasant that he changed his mind and swam upwards and inflated his lifebelt again. The three survivors were rescued about mid-day after being in the water between 9 and 10 hours.

Two of them lost consciousness before being picked up. They were in hospital 4 to 5 days and at the end of this time they were fit to travel and a month later were in excellent health.

Only one in the water vomited after about two hours. He was the one who had eaten biscuits.

The hatch by which they escaped is closed against a heavy spring. The clips were undone and when the pressure equalized the hatch opened itself with only a slight push.

They donned their apparatus before flooding the compartment, but they did not insert their mouthpieces and commence inhaling the oxygen until the last possible moment. This was not because of any instruction they received, but because they regarded the apparatus as rather an uncomfortable thing which one had to put on at the last moment, only as a means of escape. When they got to the surface they disconnected their mouthpieces and relied entirely for support on their lifebelts. Their lifebelts were, in this case, entirely separate to their Draeger gear.

U-64

The submarine was sunk off Narvik by depth charge attack from aircraft in 131 feet, in April 1940. There were eight men left alive in the submarine and it is believed they flooded the whole boat and escaped via the conning tower hatch, opening every possible valve and means of letting in water. All eight men survived and came up without any apparatus.

H-49

Sunk in November 1940 off the Dutch coast in approximately 70 feet of water. The only details known are from a conversation held in a P.O.W. camp in Germany as the sole survivor was subsequently killed in a car accident

H-49 was depth-charged, damaged and went to the bottom. Leading Stoker F. G. Oliver was ordered by the Chief E.R.A. to issue D.S.E.A. sets to all in the motor room. He did this and found he had left himself without a set. The next thing that he remembered was regaining consciousness on board a German trawler and finding that he was the sole survivor.

UMPIRE

Sank in a collision off Sheringham 0030 19th July, 1941 in a depth of 60-65 feet. The submarine was listed heavily to starboard on the bottom. "It made it possible to sit on front of the engines on the starboard side" so the list was not less than 30°. She was also bow down 10° approximately. She was holed forward.

Four men collected in the control room and 17 in the engine room. Those in the control room decided to make their escape via the conning tower. Water was pouring through the forward control room bulkhead; probably through the ship's ventilation trunk. These four men (two officers amongst them) allowed the pressure to build up in the conning tower by venting through the lower hatch and allowing the pressure from control room to enter conning tower.

There was some chlorine present in the control room but it was not bad in the conning tower. Pressure was equalized and the conning tower hatch opened after approximately 40 minutes. The men in the conning tower had neither D.S.E.A. sets no lifebelts. Owing to the shallow depth the pressure equalized before water level reached the conning tower. Of the four in the conning tower, the first to leave reached the surface and was alive and talked with one of the survivors, but he was not picked up. Two others left and survived; the remaining man, an E.R.A. was in a very bad way before the escape was made and it is the opinion of the survivor interviewed that he never left the conning tower and was drowned in it. One of the survivors (the last to leave) said he held his breath all the time. The two survivors suffered no ill effects.

Meanwhile, in the engine room preparations to escape by twill trunk were made immediately after the forward bulkhead door was shut. Of the 17 men, three had no D.S.E.A. sets.

None of the D.S.E.A. torches worked and difficulty was experienced opening the D.S.E.A. lockers due to the strong pins and wires used to secure the lids.

Owing to the list it was difficult to shut the forward bulkhead door, and tackles had to be used to do this in the dark. Flooding was normally carried out through the flooding valve provided, and the hatch was opened, when the pressure equalized, by the first pair to escape. There was a small air lock left in the trunk prior to opening the hatch.

Unfortunately it is not known how long the flooding took, but the engine room survivors had surfaced less than 1½ hours after the collision.

As there were three men without sets is was decided to send them up with men who had sets. Of the first two to escape in this way both reached the surface alive hanging on to their opposite numbers with sets, but they were not picked up and clearly drowned after reaching the surface. The third man without a set started with his opposite number with a set, but although he was alive when he entered the trunk he was not with his opposite number on the way up. What happened to him is not known. All the remainder, except one, in the compartment made various escapes with the D.S.E.A. and survived, but some of those who came up successfully only used their sets as buoyancy bags. How many is not known. One definitely lost his mouthpiece by fouling the hatch as he went out; others lost their mouthpieces when they struck the W/T mast during the ascent. One man on the way up became entangled with this mast and had some difficulty getting clear. The one man with a D.S.E.A. who failed to survive was a civilian who knew nothing about submarine escape and was in a low state of morale before leaving. Due to the angle, the D.S.E.A. ladder in the twill trunk was more of a hindrance than anything else.

The escape from the engine room was an excellent example of good leadership, cool thinking and the correct working of the twill trunk method. For example the Chief E.R.A., after some had escaped, went up into the trunk, right to the hatch to see that all was clear and then returned back into the submarine to tell the others. It is difficult to give an exact analysis, but of the 7 men who attempted to escape with neither D.S.E.A. nor buoyancy bag, five reached the surface alive. The others undoubtedly drowned by lack of some sort of buoyancy on the surface. Of the 14 atempting escape with D.S.E.A. 13 were successfull, but some of these used D.S.E.A. as buoyancy bag only.

P 32

Sank off Tripoli August 1941 in a depth of 210 ft. Probably mined forward. The submarine was dived at the time. The lights went out immediately and boat plunged straight to the bottom. When they reached the bottom the forward bulkhead door to the C.R. was already shut and jammed by the force of the explosion. Some ratings were still alive forward but the door was jammed and could not be opened. Shortly afterwards these men were heard screaming and then silence so it was presumed the compartment flooded forward fairly quickly. The remainer of the crew was still alive 24 in all. They went into the E. R. but owing to the congestion, three (1 officer and 2 men) went to the conning tower to make their escape from there.

The D.S.E.A. sets were all got out and after the forward E. R. bulkhead door was shut the men in the C. R. heard those in the E. R. start flooding up; but none survive from the E. R.

It is fairly certain that the reason for this failure to escape was the E. R. D.S.E.A. hatch being clipped down from the outside. In some submarines it was the practice during the war to clip down these hatches to prevent the hatches leaking due to "jump" when depth charges exploded very close.

The submarine was listed **about 20°.**

The Officer(P. O. and E. R. A. climbed into the conning tower. Pressure was equalized by flooding. As soon as the pressure equaized the hatch was opened and they escaped. The E. R. A. escaped first, then the P. O. and then the officer. All three wore D.S.E.A. sets. The E. R. A. reached the surface but was dead; he was alive and had his wits about him before leaving the conning tower. On the surface he still had his mouthpiece in but the exhaust valve was shut; his eyes were bulging and his face grey and when attempts were made to remove his mouthpiece, blood came out.

None of the three had any trouble or experienced any real distress when flooding up.

The P. O. was a tall, rather timid man, with average physique. He used his set as follows:—

"I did not have any air in my set, but I fitted it on and, remembering my drill, when the sea pressure inside the conning tower had equalized outside I filled my bag up by taking air in through my nose and closing the mouth cock. The E. R. A. then went up and I took in a breath of air, put my clip on and followed him straight away. I had to hold my breath, but I had to open my mouth and took in 2 or 3 mouthfulls of water. However, the next moment I broke surface. I did not breathe oxygen in the conning tower at all".

Kirk had his mouthpiece cock shut before he started the ascent, during the ascent and on his arrival at the surface.

The officer worked his D.S.E.A. set correctly and used the apron for the ascent.

The P. O. was in the water for 1½ to 2 hours before being picked up.

PERSEUS

This submarine was running on the surface, in December 1941, in the Channel between Zante and Cephalonia in the Mediterranean and was apparently mined and sank rapidly to the bottom in approximately 170 feet of water.

There was one survivor. The story of the survivor is as follows:

"Exactly at 10 o'clock there was a very considerable explosion and the boat went over to about 25° to starboard and in a matter of about 3 seconds was vertical, bow down. I was in the after bulkhead going to the stokers' mess. Stores, etc., were falling all round. In about 5 seconds she fell straight back to the horizontal position, slightly stern down. She then hit the bottom and went still further over to about 30°. You could not stand on the deck at all; you had to hang on overhead. Before she reached the bottom all the lights had failed and the battery was out. I was in complete darkness. The bulkhead door shut itself.

For about ten minutes I was feeling my way about trying to find a D.S.E.A. torch or the secondary lighting. Eventually, in the starboard bilge I found a D.S.E.A. torch. Water was seeping in all around and coming in through Z. I went into the stokers' mess and found three fellows under the lockers. All the overhead woodwork had collapsed. The men were slightly injured but fairly sensible. I went through the mess bulkhead to the motor room; there all the switches had come down and one L.T.O. was completely burned. I then went through the bulkhead to the engine room and by the time I got there it must have been anything up to 20 minutes.

In the engine room water was over the tops of the engines and just seeping back into the motor room. There was no one alive above the water. The boat was slightly down aft. The engine room bulkhead door itself was shut and tight, but it had no clips.

I proceeded back aft and shut the engine room door and put the dogs on it. I examined the L.T.O. but he was definitely dead and I left him, I didn't bother to find out who he was. I shut the motor room door and in the mess the three young stokers had extricated themselves and were sitting on the

deck which was at a big angle. I told them to get back aft which they did and we shut the compartment door and clipped it.

At this time I thought we had better consider flooding. It took half an hour to clear all the stores and boxes, etc., that had fallen from the space under the D.S.E.A. trunk. The pressure then was still very slight, almost normal. There was no smoke. I attempted to use the flooding up valves but they were useless. On the starboard side of the PERSEUS was the underwater gun which was in a favourable position for flooding by opening the breech. The water came in at considerable pressure up to my waist in three minutes. We got the D.S.E.A. sets out, but did not put them on. When she was flooded half way up I shut off and we got the trunk down, and secured it. I flooded up again and by this time breathing was painful. I continued flooding until no more water would come in. It was then well up to my chest. During flooding up I could hear a hissing noise and assumed it was air going out of the hull. With the help of a spanner I undid No. 4 H. P. air group to the underwater gun and let air come into the compartment as I was afraid that, with the hull leaking, we would be flooded before we could get out. I succeeded in getting air in all the time from the after group.

I still had my D.S.E.A. set, out of the water, but I did not put it on. I dived down and got inside the trunk and found there was about two feet of air inside. I undid the four dogs and water began to seep in through the rim of the hatch. I gave the hatch a heave and nearly went out in the bubble. The other three fellows had their sets on and I saw their exhaust cocks were open and they went out. They had to be pushed out and they had to help themeslves because of the angle. I then put on my set and adjusted the nose clip and dived down. Immediately I got inside the trunk there was such a blast of air that it knocked the set off. I returned to the compartment and put the mouthpiece and nose clip on again and put a little gas in the lung because I had lost it all. I had the exhaust cock open and everything was working properly, although there was one disadvantage, a drum of enamel had burst open and it was all on the surface of the water inside, so that immediately you dived down you were covered in it. However, this time I held the set on with one hand and in the other held the torch. I eased myself out, feeling for the jumping wire. and steadying myself by putting my feet in the rim of the hatch. I let myself go, holding the apron out most of the time. It took about two minutes to come up.

I felt no ill effects at all. It was a bright moonlight night and there was nobody in sight at all. The other three could not have reached the surface. I had to swim about 7 miles to the shore. I kept the set on all the time and it kept me up very well."

(Note: The whole of this escape should be treated with reserve as there are various incidents difficult to account for. Three different authorities who all saw this man separately are doubtful of the whole story. There is no other means of checking the facts and it is impossible this man who was only taking passage in PERSEUS, may have been on the bridge or in the control room and got out before she sank. At the same time there is no direct evidence that his story is not in substance corerct).

X 3

Sank on 4th November 1942 at 1350 in Loch Striven in a depth of 114 ft. due to a leaking engine valve. The whole crew, consisting of three officers, all made a successful escape after the submarine had bottomed. Two of the survivors have been personally interviewed by the Committee.

Immediately the submarine dived it was realized that water was coming into the boat and she was brought to the surface at a very steep angle 80° bows up, but only stayed on the surface about 5 minutes before sinking rapidly by the stern. All possible methods of surfacing after sinking failed. The motors continued to run until the boat bottomed. Very shortly after hitting the bottom chlorine appeared and all three donned their D.S.E.A. sets. Lates was the first to enter W. and D. hatch and the flooding of the W. and D. was done by opening the equalizing cock in the top hatch. The forward hatch of W. and D. was shut and Lates shut the after hatch before flooding. The

method of flooding the W. and D. was very slow as the pump was not working. Lates was exposed to a shower bath and he felt cold, miserable and frightened. He was breathing from his set very fast and his oxygen ran out in about 20 minutes, he thinks. He was nearly unconscious, but he opened the forward door of the W. and D. and went back into the control room where he lost consciousness.

Gay, the second survivor interviewed, stated that when Lates came back into the boat he looked very frightened, was almost hysterical, was shaking all over and complained of being unable to get any oxygen to breathe. Immediately after that Lates lost consciousness. The other two officer place another set over the one Lates was wearing and stuck the mouthpiece in his mouth. He was only breathing the atmosphere from the boat for about half a minute. Gay the second survivor interviewed now entered the W. and D. but flooded it up this time with the forward door open. The boat itself was flooding more rapidly now. It had been flooding on its own from the moment of the accident. Lorimer and Gay had opened an induction valve and this apparently did increase the rate of flooding. They also tried to breack the glass of some scuttles to increase the rate of flooding but this was unsuccessful. Gay pushed open the hatch of W. and D. as soon as the pressure was equalized which took approximately 20-25 minutes from the time they bottomed. (Note: From account of surface vessel the first survivors appeared approximately 30 minutes after submarine sank).

Gay breathed from his set the whole time, i.e. from the time ship bottomed until he made his escape. He carried out the drill completely; he drained his lungs and the bag before he put oxygen into it. He was therefore breathing pure oxygen for about 25 minutes before opening the hatch. All this time the water was gradually flooding up until it was level with his face and he was in a continual shower of water the whole time. He experienced a slight feeling of breathlessness before he actually made his escape, but attributes this to his exertions whilst trying to open the hatch. After opening the hatch he climbed out of the W. and D. and intended to remain there in order to pull Lates out, as he was unconscious, but unfortunately he did not hold on to anything and immediately started to float up. He pulled his apron out and came up at the standard 45° angle. His exhaust valve was open all the way up. He remembers breathing in from his bag at the beginning of the ascent but not after that. He had a nose clip on and his mouthpiece in all the time. He stated "It was lovely going up". He had not pains in his chest at all. At the surface he carried out the routine drill and felt no ill effects except soreness of his shoulder muscles. These remained sore for about 3 days and he attributes this to muscle soreness following his exertions to open the hatch and climb out of W. and D. but it may have been due to mild bends.

After Gay had left, Lorimer thrust Lates into the W. and D. Lates recovered consciousness at this point. He came to with the sensations of terrific pressure on his ears and stinging of his eyes due to chlorine. He was wearing two D.S.E.A. sets and as he was thrust through the forward door of the W. and D. the mouthpiece of the set he was breathing from was knocked out of his mouth. Somehow he passed through the upper hatch of W. and D. and he then opened his eyes and struggled, swimming to the surface. On the way up he held his breath as long as he could and then released the air from his lungs through his mouth. He thinks he released too much as, just before he reached the surface, he wanted to breathe in and did in fact got some water in his mouth but almost simultaneously broke surface. Gay states that when Lates reached the surfce he was hysterical. It is considered by the physiologists that Lates' condition was one of syncope produced by over breathing and this view is supported by the fact that both his sets were found to contain oxygen after he had been rescued. It should be noted that none of the three survivors suffered from any marked or permanent ill effects.

UNTAMED

Sank about 1400 on 30th May 1943 in 160 feet of water off Campbeltown. No survivors. Submarine was subsequently salvaged and examined

Disaster was due to faulty operation of the "Ottway" log causing extensive flooding forward. Two men were trapped in the crew space which had been flooded in an attempt to escape.

For about four hours attempts were made to surface the submarine which were entirely inadequate and, in many cases, incorrect. Preparations to escape were not made until this period had elapsed and it is presumed that this was due to the fact that at this time there was accessonly to a limited number of D.S.E.A. sets, and because the D.S.E.A. flooding valve, which is especially fitted for flooding the compartment, was defective.

The more obvious alternative methods of flooding were not used resulting in a very slow rate of flooding through the main line. Also a drain into the after ends was left open resulting in that compartment having to flood up as well.

It is estimated that flooding must have taken at least an hour by which time the danger of CO2 poisoning must have been acute.

Evidence shows that escape by the conning tower was considered but discarded as being too difficult.

Examination after salvage showed that all available D.S.E.A. sets were in good order and had been worn correctly. 10 men in the engine room were without sets.

From a tabular statement showing the state of D.S.E.A. sets after salvage, half the sets were full and half empty, or nearly empty, and in most cases the mouthpiece cocks, and exhaust were shut. From this it would appear that the effects of CO2 were not appreciated until too late and the most of the crew succumbed without attempting to use their sets as a breathing apparatus in the foul atmosphere.

WELLMAN X

As the result of an accident the WELLMAN craft sank in 186 feet of water with one man on board - a Norwegian. The boat sank with a steep angle down by the stern. After vainly attempting to surface the craft this officer set about escaping. The boat was flooding rapidly. He started up the direction indicator which kept air ciruclating and put on the Momsen Lung, charging the lung up with oxygen by means of the flexible connection provided. He smelled chlorine so started to breathe from the lung, but as the water rose he floated up with it thereby breaking the connection to the main oxygen supply. He then broke the oxylet and tried to open the hatch but the pressure had not yet completly equalized. He dipped under water and connected the flexible connection and so got more oxygen into the lung. But the supply soon ran out and a few minutes later there was nothing left to breathe from. Again he tried to open the hatch and this time he succeeded. He states the rate of ascent was slow and began to feel himself passing out through lack of oxygen, at what he thought was about 30 ft. (He states "It had grown quite light".) He lost consciousness.

Loss of consciousness was almost certainly due to a lack of oxygen, plus asphyxiation due to almost drowning. He was under water a considerable time before escaping and when he lost consciousness his mouthpiece fell out of his mouth.

The officer surfaced approximately 20-25 minutes after the boat sank. When picked up (there was a boat immediately on the spot which picked him up the moment he surfaced) he was floating face downwards and unconscious. 30 seconds approximately after surfacing he was breathing, although poorly. He had his Momsen lung on, but the mouthpiece was out of place.

Artificial repiration combined with the Novox resuscitator soon restored normal rhythm, which was only disturbed by frequent vomiting. This may have been due to Chlorine but most probably was due to the salt water swallowed. There was no smell of Chlorine either on the patients breath or in his vomit. The vomiting continued for half an hour after Pederson was in bed

and by this time he was only bringing up a little blood stained mucous probably due to rupture of small blood vessels caused by strain of retching. He was of course suffering from cold and shock but his recovery was rapid and apparently complete. Thanks to his magnificent physique and the fact that he was able to receive immediate skilled attention he was, two days later, back at work entirely confident and treating the whole matter as part of the days work.

U 533

Sunk by a/c in the Persian Gulf on October 17th 1943. The submarine dived as soon as she sighted the a/c and the first depth charge exploded when she was at approximately 75 ft. All the lights went out. At 180 ft. approximately, another depth charge exploded near the hull and she sank. This holed the submarine and she flooded throughout very quickly indeed.

One officer and one man got out. They were in the conning tower at the time and they suddenly found themselves up to their necks in water. The officer opened the conning tower upper hatch at once and they both shot to the surface without any Draeger gear. Whether or not they had lifebelts on is not known. Both reached the surface, but the officer was unconscious. The rating supported him on the surface for nearly an hour, but he did not regain consciousness. The rating himself states he lost consciousness for a short period but came to on the surface.

This rating then swam to the coast and was swimming for 28 hours (prisoner's word only for this).

The depth from which they came up is uncertain, but it was certainly 180 ft. or deeper. Both men were under pressure for a very short time indeed before they started ascending.

U 741

The submarine was diving at 150 ft. approximately, off the Isle of Wright and was sunk by depth charges and sank to 190 ft. approximately.

The submarine was badly holed and started flooding quickly. The bulkhead door at the after end of the control room was shut but leaked badly. The pressure aft in the boat had already increased considerably before the survivors started to flood up. There was a certain amount of chlorine present.

The method of flooding was via the Diesel exhaust valve and then through the inboard drain, approximately a 4" diameter pipe.

There were 12 men in the after part after the accident; all had Draeger breathing apparatus.

There was possible 3% CO_2 present before the accident as the submarine had been submerged from 12 to 15 hours previous to the accident and for some unknown reason had not been using the purifiers (this is only the survivor's statement and cannot be relied on implicity; they may have been running some of that time without his knowledge).

The order to don their Draeger gear was not given until there was considerable pressure in the boat, and it was not until some of the men passed out (obviously with CO_2 poisoning from the high partial pressure) that the remainder donned their equipment and started breathing oxygen. All were panting for breath before donning their apparatus.

The submarine was listed approximately 40°.

About 10 minutes after the disaster they started flooding. (**Note**: there was some pressure already in the compartment before flooding started). Flooding lasted approximately 25 minutes, until the hatch could be opened. Approximately 15 minutes after the flooding started several men started to shout and scream and said they had no air and became unconscious. (It is not certain whether they were getting oxygen poisoning or had run out of oxygen —it is more likely oxygen poisoning).

At this time there must have been a very high concentration of CO2 as the survivor stated he tried taking his mouthpiece out to breathe from the air pocket to save oxygen, but he felt his throat contracting and it was impossible to breathe after taking only a very few breaths. The water in the compartment was waist high by this time.

A stoker P.O. first started to try and open the hatch, but as soon as he commenced making the extra exertion he could not get more air and fell back into the water.

At this time, when the pressure was practically at its maximum, anyone who started doing work passed out. (It must be remembered that all were wearing Draeger gear — capacity approximately 30 minutes).

As the pressure started to reach its maximum, several men complained of ear trouble and became very excited about it. The survivor cleared his ears by blowing, with his fingers holding his nose.

Towards the end the men became very quiet and only four or five could talk at all; one after the other they passed out. (Did they go out with oxygen poisoning or lack of oxygen due to the bottle being expended? It is probable it was oxygen poisoning as had it been lack of air, it is more likely they would have dragged their mouthpieces out of their mouths to breathe in from the air pocket. From one survivor's report they did not do this, but passed out with their mouthpieces still in their mouths).

The survivor, realizing that the men were passing out possibly because their oxygen was running out, managed to get hold of a second unused set which he donned. He managed to get the hatch open. There was no twill trunk in this hatch and therefore there was a large air bubble that was released as the hatch opened. He shot out in this buble and ascended very fast indeed, in fact when he reached the surface he bounced out of the water to waist level. Before leaving he noticed his oxygen was nearly finished (this may have been that the bag was merely collapsed due to the pressure and he had not put enough in). As soon as he left the hatch and started to ascend he felt the oxygen bag expanding and he at once started to breathe more freely. He felt that he could breathe more freely as he was only a few metres away from the boat. He had his mouthpiece in his mouth all the way up. When he reached the surface he was almost unconscious and had great difficulty in keeping himself affoat. He later had pains in his knees and ankle joints, but no pains in his chest. He still felt the pressure in his ears. He was sick in the boat which picked him up, but he himself attributes this to the oil fuel he swallowed, as there was a lot of this in the compartment during flooding up.

One other survivor reached the surface alive and shouted, but sank just before the Corvette's boat reached him. He was also wearing a Draeger. Probably he forgot to blow it up and shut the valve, consquently it dragged him under.

STRATAGEM

She was sunk by depth charges in the Straits of Malacca in November 1944 and sank rapidly to the bottom in 150 feet of water.

The submarine was diving at the time and had already been submerged for about 6 hours. The following is the accounts of an officer who escaped:

"Almost immediately a depth charge exploded somewhere extremely close under us, lifting the stern and causing us to hit bottom hard. This charge extinguished the greater part of the lighting, although one or two of the emergency lights held. About five seconds later a second charge exploded, as far as I could calculate, right amidships, extinguishing the remaining lights. By this time I had a torch in operation and could see water flooding through the door at the after end of the torpedo stowage compartment. Immediately, I gave the order "Shut water tight doors" and turned to make sure that the three ratings in the tube space were brought out of that compartment before the door was shut. By the time this door was shut, the water was flooding very much faster and had risen above the deck boards in the stowage compartment.

It now was above our knees. It was flooding through the after door so fast that the ratings were unable to shut this door. The position of the stop (retaining door in open position) on this water tight door was such that to remove it one had to stand in the doorway as the port side of the door was blocked by stores. Hence, due to the furious rate of flooding, this could not be removed. "In what appeared to be an incredibly short time, I was keeping above water by clinging onto a hammock which was slung from the deck-head. The crew in my compartment began to sing, but I ordered this to stop and told the crew to get out and put on their D.S.E.A. sets. The first I managed to reach had a defective valve on the oxygen bottle and I could not move it. The second was in working order and I put this over the head of one of the older ratings who was panicking and in tears due to the pressure effect on his ears. The pressure in the boat at the time was immense and the chlorine content in the air considerable. The water all round us must have been full of oil as we were all drenched with it, although I did not notice it at the time. The air could be heard to be escaping through the hull forward and the water was still rising fast. At this time Leading Seaman Gibbs was in the escape hatch trying to slack back the clips. He shouted to me that he could not move the third clip. Speaking was nearly impossible due to the pressure. I swung up into the trunk alongside Gibbs and tried to remove the clip. After what seemed like an hour, and what I suppose was really a minute, I managed to move the clip by hammering it with my fist. By this time there was no hope of using the escape trunk as the water was already up to the metal combing which houses the twill trunking. I took off the last clip and as I did so the hatch commenced to open. Immediately this clip was free the hatch was blown open and Leading Seaman Gibbs was shot out so suddenly that I cannot remember him going. The hatch slammed shut again and hit me on the top of the head but immediately blew open again and I was shot out in a bubble of air".

Ten of the men in the compartment, which contained fourteen at the time, are known to have left the submarine alive, although only eight were picked up. The Ship's Cook was later seen to be floating, face downwards, on the surface but was obviously drowned; it is not known whether or not he wore a D.S.E.A. During the flooding up and prior to escape this man was fit and active and his morale was good. Another rating came up with a D.S.E.A., but it is practically certain he had the mouthpiece cock shut. He was in a very bad way on the surface and would have drowned had not one of the other survivors on the surface blown up his D.S.E.A. bag by opening the oxygen bottle. Another who wore a D.S.E.A. set is belived to have left the submarine with it but was never seen on the surface, this was probably the man aged 55 who was in a very bad way before the escape and could not have been expected to survive in any case. Three others were seen to be handling sets before the hatch was opened but it is not known whether any of these survived or if they did, whether they had time to don their sets or not.

The Jap Destroyer dropped two more charges after the submarine was hit, but these were not so close and did not do any more damage although they probably accelerated the flooding.

"Throughout the above experiences the behaviour of the crew in my compartment was magnificent".

H. P. air was escaping all the time during the accident and it is known that they had an excess pressure in the submarine over the sea pressure. The effect of pressure was described by the officer as follows (the pressure at this time must have corresponded to a depth of 160 feet) :—

"Speech was practically impossible; one could make movements with one's mouth but no noise came. One's head was swimming and you could not think quickly. You could not hear anything except a ringing sound, and it felt as if one had been holding one's breath for a long time".

The time of sinking to the escape was probably under 15 minutes.

Of the 14 men in the compartment only one apparently suffered seriously from the suddenly rising pressure. The men behaved very well under the increasing pressure.

The officer stated his ascent seemed very fast and he felt the air being forced out of his lungs as he ascended. Apart from a pain in his chest some 48 hours later and fair severe bends which lasted for 3 days, he was none the worse. Once the hatch opened the men escaped very quickly.

A sailor who survived also felt the air being forced out of his lungs as he ascended.

Both the officer and man interviewed considered that, while they were under high pressure, they would not have carried out simple orders or worked valves, etc.

U 1199

The craft, which had been Schnorkel cruising for 3 - 4 days, was badly damaged by depth charges and bottomed at 73 metres (240 feet) with a list of 35° - 40°. She sank off the Wolf Rock. At this time the whole crew of 47 were alive and orders were given to abandon ship and stand by with life-saving equipment. Claussen was in the control room together with the Commanding Officer, the Engineer and control room personnel, all of whom, with the exception of the 1st. Lieut., had Draeger gear, but no swim-suits. It was a standing order that anybody on watch carried his Draeger gear even if he only went from one compartment to another.

No bulkhead doors were shut and flooding was rapid through the damaged hull and through the outboard vents of the trimming tanks which were opened for the purpose. There was no chlorine.

Claussen was first in the conning tower followed by others crawling up the ladder and the time between his entering the conning tower and opening the hatch was a matter of seconds rather than minutes. He was unable to give any estimate of the time between commencement of flooding and his escape, but it must have been several minutes.

During the flooding he had been breathing oxygen from his set and was totally submerged before being able to open the hatch; there being no air-bubble in the conning tower.

At this time he was wearing his Draeger gear with mouthpiece cock open. He had opened the oxygen valve slightly when first donning the gear, opening it further as pressure increased, but had forgotten to close it again later. It is probable that he also forgot to open the exhaust valve. Before leaving the draft he experienced a sensation of great pressure which caused a ringing or humming in his ears and, after having lifted the hatch, felt very weak and quite incapable of further physical effort. This weakness persisted for the first few feet of his ascent which was rapid, but feeling his chest to be intolerably expanded he held his nose and twisted the mouthpiece to allow gas to escape from the corner of his mouth which relieved both discomfort and weakness. This was a spontaneous action and **not** the result of training. He continued to release gas during the remainder of the ascent and noticed that he was rising more slowly. At the surface the set was deflated and he subsequently blew it up by mouth to give himself buoyancy. He was on the surface for about 10 minutes before being picked up.

He experienced pains in his chest and in his knees for 2 - 3 days, but had no trouble with eyes or ears and brought up no blood. He had been trained in the use of Draeger gear at the usual depth of 18 ft.

Of the 46 men alive and provided with sets when the craft bottomed, only 1 man escaped successfully although flooding was rapid, and some were actually on the ladder of the conning tower just behind the sole survivor.

The most probable explanition of this fact is that all collapsed with oxygen poisoning having been breathing from their sets for some minutes under pressure. Claussen's loss of strength and difficulty in muscular movement seem likely to be advance symptoms of collapse from oxygen poisoning; a view which is strengthened by his rapid recovery on releasing pressure by twisting the mouthpiece. He, in fact, escaped only just in time. It may be that Claussen's suggestion is correct (that the man following him got stuck and

prevented others from emerging) but again the effects of breathing oxygen under pressure would so weaken the crew that the additional effort of clearing this obstruction might produce collapse.

The ascent was, in effect, accomplished with buoyancy only. Claussen allowed air to escape from his lungs continuously and although he stated that he felt a desire to inspire **he was unable to do so.** It is, however, a fact that buoyancy was lost during ascent by escape of gas through the twisted mouth-piece and this would help to avoid the risk of burst lung and of vascular embolism in the last stages of the ascent.

U 399

This submarine was sunk on March 26th 1945 at 5:20 a.m. by depth charges. She was submerged at the time at a depth of 50 metres, i.e. 160 feet and sank settling on the bottom at a depth of 60 metres, i.e. 190 ft. The submarine had been submerged for the previous 24 hours, all of which were spent on the bottom. The Engineer Officer and P. O. in the control room were responsible for testing the air. The air was still quite good in the boat at the time of the attack. It is presumed that the CO2 absorption unit had been working, but report does not state so definitely.

Pflock was on watch in the control room and was alongside depth guage. They were at 50 metres depth when attacked and the Engineer Officer told him they were then 10 metres above the bottom

The second depth charge made a large hole in the stern and water commenced to pour in. The crew had not all got their life saving equipment with them and Pflock himself had none. He made his way into the conning tower where there were two others, also without breathing sets. The water rose very rapidly and he told one of the others to open the hatch. While he was opening the hatch the water was up to their shoulders. They were all three very nervous and scared stiff. Just before the hatch opened the water was almost up to the top. Pflock took one deep breath and shot out. The other two men never left the boat as far as he knows. He thinks they just held on to the rail and never made an escape.

On the way up to the surface he did exactly what he had been told. He held his arms out wide to slow down his rate of ascent and allowed the air from his lungs to escape through his mouth. All the way up he had no desire to breathe in. He had no sensations during the ascent probably because he was so scared. He does not think he was in the conning tower more than two minutes before he made his escape.

After reaching the surface he was in the water about ¾ hour before being picked up. It was March and the water was very cold. Coldness was the only sensation he had. He swam to the Corvette, but had to be hauled on board from the lifeboat, he was so weak. After getting on board he began to feel pain in his chest and was taken to the Sick Bay where they gave him artifical respiration, after which he began to feel better. He couldn't lie down properly because of the pains in his back. Breathing also remained painful for some time. He suffered no eye trouble or visual disturbances.

Just before he escaped and when under high pressure he states that he could not have done anything at all. He was very scared, and fully resigned to death. He has no idea how long it took him to ascend to the surface, but it seemed a very long time.

Notes:

(a) This escape bears out entirely the draft report statement that men escaping are often scared, numb and stupid.

(b) There is little doubt there must have been at least two per cent of CO2 in the boat before it flooded, and yet Pflock took a deep breath of highly compressed air just before leaving the boat. He was scared and stupid and would have been expected to do all the things conducive to drowning. This is a typical example of a man who is terrified making his escape and

yet he knew he had to breathe out, from his training, which he did. It it not a true statement that special training is required to enable a man to come up without any apparatus.

X E 11

Rammed and sunk by a trawler at 1125 on 6th March 1945, in Loch Striven. Depth 204 feet. Two men escaped and survived, neither of them wore D.S.E.A. at any time. The men surfaced five minutes after the trawler's propeller holed the submarine. Submarine was diving at the time of the accident and had been submerged about 20 minutes, no air purification working during that 20 minutes. Submarine was hit forward and listed temporarily to about 40° then the trawler's propeller hit and holed the submarine aft. C.O. ordered W & D top hatch to be opened, this was unclipped, but naturally could not be opened owing to water pressure. She sank to the bottom stern down nearly vertical (survivor's estimate) water pouring in aft all the time.

When she hit the bottom she straightened out and settled without any appreciable list. E.R.A. Swatton at time of accident was in control room. First Lieut. was in W & D when she hit bottom and Swatton was half way into W & D. The two W & D hatches leading forward and aft were open all the time. By the time the pressure had equalized Swatton and First Lieut. were both in the W & D with their heads in the air lock. The top hatch was already unclipped. Owing to the very large hold aft the pressure equalized in a few minutes, possibly not more than 3 minutes. A shower came in round the lip of the top top hatch when the pressure was practically equal, but this shower did not prevent the two men breathing in the air pocket right up to the hatch being opened. There was still an air pocket when hatch was opened, which at the end, was approximately 4". They had to force their heads back to breathe in it. Swatton pushed hard to open the hatch but doesn't remember taking a deep breath before coming out. Neither had any lifebelt. Swatton never felt any pain in his ears at any time, neither did the First Lieut. complain.

Swatton was a poor swimmer.

He was conscious and thinking fairly clearly all the way up (he states he was actually thinking more clearly than he had ever thought before in his life). He remembers the water passing from very dark green (almost black) to light green on the way up. He consciously thought that he might want to breathe out on the way up because of the big pressure at which he had been. He did so well all the way up by puffing through his lips, about half way up he felt he would like to breathe in but decided definitely to hold his breath until he surfaced. In actual fact he refrained from breathing in and thinks he never stopped breathing out all the way up, at no time did he feel a deperate urge to breathe in. He didn't notice that he was breathless on breaking surface.

It must be remembered that this man had done a course of diving. The interesting point is that suddenly, on the way up, it dawned on him that he must breathe out, this was probably an unconscious reaction to the rising pressure in his lung added to his knowledge of the subject. He swam slightly on the way up. No water entered his mouth or nose on the way up, neither does he remember any air going out of his nose. Swatton, on surfacing, felt no ill effects at all, nor did he feel any later. He was picked up almost immediately after surfacing.

The First Lieut. left the submarine immediately after Swatton, in fact practically simultaeously, they arrived on the surface together.

This man's evidence bears out the confidence inspired by knowledge and training is of the first importance, the man himself agrees.

As regards the First Lieut. he states in his evidence:—

"Just at this time, immediately after hitting the bottom, I had given up all hope of getting out and resigned myself to keep calm until the end. Pressure was becoming acute and I kept clearing my ears. Suddenly water poured into the W & D. I was not fully conscious because I cannot remember clearly what

did happen, but I imagine we had bottomed and levelled off. I thought the hatch had opened itself with the pressure, but E.R.A. Swatton pushed it open. I was aware of being shot up. I was aware of going through the water and I imagined I was coming up to the surface".

Swatton stated that the First Lieut. who reached the surface almost simultaneously with himself, was unconscious and he grabbed him as he was sinking. He was still unconscious when he was brought on board the trawler but was brought round by arifical respiration and later in the afternoon he was alright and was none the worse afterward.

U 1195

This submarine was sunk in April 1945 in the Channel off the Nab. She was submerged at approximately 75 feet when she was holed by depth charge forward. She rested on the bottom in 96 feet. Nearly all the crew was alive — approximately 50 in all. These split into two parties, one lot of 33 went into the after part, the remaining 17 went into the control room.

Taking first the escapes from aft. There was an officer in charge. All the clips were taken off the escape hatch and the hatch secured by a piece of rope. This could then be cut when the pressure equalized and the hatch would open itself. (In German submarines the hatches are shut against a spring, This hatch had a twill trunk which they rigged.

The submarine was listed to approximately 40°. All the men had Draeger gear except 4 or 5. The officer in charge had a Draeger set, but the oxygen bottle was not working. Those without Draeger sets were given life jackets and one man dinghies and were to make their escape first. As soon as these preparations were complete they started to flood the after part of the boat i.e. from the after control room door to right aft. They flooded the boat through the Diesel exhaust drain by opening main exhaust valve and then the drain to this exhaust - approximately a 4" diameter pipe. Fortunately the officer had a watch and he states quite clearly that from the time of flooding to the escape it was 20 minutes. He stated the flooding seemed very slow and was bad for their morale.

During the flooding the batteries in this part of the submarine started giving off Chlorine so that they shut the door to this compartment which helped to isolate the chlorine.

At first, apart from the coughing due to the chlorine, all went well, but as the water and pressure rose the situation started to deteriorate.

The men with Draeger sets started breathing from them as soon as flooding up started - the men's eyes were running. They were breathless and "snapping for air like fishes".

The officer was very worried as to how to get the men into the bottom of the twill trunk owing to the excessive angle of the submarine. When this officer reckoned the pressure was equalized he sent a Stoker P. O. to open the hatch. This man was wearing a life jacket, but no Draeger gear. The P. O. succeeded in opening the hatch, but was drowned in the process and was left gripping the coaming or rail and it took three men to finally pull him back into the compartment.

The escape then started. Those without escape gear, but with life jackets went first. The officer stationed himself at the bottom of the trunk and literally thrust each man down and under the twill as they had difficulty in getting down and under due to the buoyancy of their life jackets. He was under water each time he did this bobbing up to breathe from the air pocket between each escape. Except for the Stoker P. O., the four who went out thus, without Draeger, reached the surface successfully and survived. One with Draeger gear then went up.

The officer went up next. As his oxygen bottle was not working he blew up his Draeger bag with his mouth while his head was in air at the top of the compartment. He then took a deep breath and tried to get out but

was caught up due to his gear fouling the twill, owing to the angle. He repeated the procedure a second time time and again got caught. The third time he went right under by holding on to the deck and then got safely through the trunk. For the ascent he had his Draeger blown up as a lifebelt, the mouthpiece in his mouth with the mouthpiece cock shut. He states he put the mouthpiece in his mouth as the mouthpiece cock was leaking and he did not want the air to go from his Draeger bag.

He swallowed a little water during his struggles to get under and through the trunk. He reckons he must have been a minute struggling under water before he got clear. He held his breath after getting out for what he guesses was about half the way up; but all the time he let air escape out of his mouth as he had been taught. His minute of struggling plus the air he had deliberately let escape finally made him want to breathe in before he reached the surface. Although he wanted to breathe in very badly he managed to keep his mouth firmly shut. Some water came in through his nose which finally stopped him trying to breathe in. He distincitly felt the expanding pressure in his lungs on the way up. He was in the water about 10 to 15 minutes before he was picked up. His eyes and lower part of his chest hurt him after rescue. The pains in his chest made him feel that he could not get enough air, but these pains wore off after about 20 minutes. His nose was permanently running for about 3 hours. He had no other pains and no visual disturbances; although his eyes still hurt him when it is cold.

When this officer reached the surface there was another survivor, in a dinghy, in a very weak condition who was suffering with his chest. This man had been breathing from a Draeger set before he made his escape and as far as is known he had the mouthpiece in when making the ascent. This man, before the escape, had lost all hope and was very demoralized and had to be shouted at before he would do anything

After Schick had made his escape, the Ship's cook, wearing only a schwimmveste, became jammed at the bottom of the twill trunk.

Fduhwald was sitting on top of the starboard diesel. The remainder in the compartment surged forward in a panic round the twill trunk. He heard the hatch Chief E.R.A. shout that the only means of escape now was through the after torpedo hatch. He then made his way aft to the torpedo hatch, found it open, and made his escape. He considered that the Chief E.R.A., who had no apparatus, was overcome by the surge forward of the remainder (these were all inexperienced and rather panic striken young stokers).

He noticed during the flooding up that a powerfully built man who was sitting right forward and not wearing a breathing apparatus suddenly collapsed.

On leaving the hatch he shut his exhaust valve and ascended very rapidly spite of the fact that he held his arms and legs out to slow him down. The bag expanded, forcing air out of his mouth past the mouthpiece. He thinks that he breathed in during the ascent. On reaching the surface the mouthpiece came out of his mouth and the bag deflated, so be blew it up as a buoyancy bag.

He considered that Neiderhausen, who assisted him in flooding the compartment and who remained aft the whole time during the flooding up, made his way to the after torpedo hatch as soon as the pressure equalized, opened the hatch, which was submerged due to the list, and escaped, as he was already in the Corvette when Fruhwald was picked up. (Note: Due to the list the air pocket in the compartment would remain when the after hatch was opened).

A W/T operator who escaped out of the twill trunk with Schick did not put on his set until the moment of escape and was very ill after being picked up. Fruhwald suffered no ill effects.

Seventeen men, including the Captain and 1st Lieut. went into the control room and started to make their escape from there. Three of the seventeen had no Draeger gear, but these three had lifebelts.

They flooded up through Q tank (presumably by kingston and inboard vent) also via the ballast pump. The three without sets were sent up into the conning tower to escape first. The remainer with their Draeger were collected in the control room. The lower hatch leading from control room to conning tower was open. There was a certain amount of confusion. During the flooding up a lot of oil fuel came in with the water and bothered the men's eyes.

The flooding was upset by rivets overhead in the pressure hull leaking. The escape of air due to leaking rivets overhead meant that there was no air pocket left in the control room when the pressure had equalized and the only air pocket left was about 4 to 6 inches at the top of the conning tower. Thus everyone in the control room was completly submerged.

The three without sets were left with their heads in this tiny air pocket in the conning tower. They opened the hatch and went up. (The survivor whom the Committee examined, Gmoehling an Engineer, was most intelligent and lucid. He had also taken considerable interest in escape during his Draeger training).

One of these three described in detail how he and the others were breathing very rapidly in this tiny air pocket immediately prior to opening the hatch. He also stated he was unable to take a deep breath before leaving as there was so little air left (and that little contained CO2 at a high partial pressure). In this high concentration of CO2 he states he found it very hard to hold his breath. But (and this is most interesting) although he had been panting hard and found it difficult to breathe before the hatch opened, as soon as he started ascending he no longer **wanted to breathe in.**

As he ascended he let air escape out of his mouth as he had been taught to do so. He states "he just opened his mouth and away it went." He let out air all the way up.

After leaving the boat at first he felt he was going too slowly, he therefore let more air into his lifejacket (not the Draeger set which he was not wearing). He then went up faster and at no time did he attempt to check his ascent. He felt no ill effects after reaching the surface. He stated quite clearly that he had no desire to breathe in on the way up; on the contrary he had too much air and wanted to get rid of it.

Fortunately the survivor interviewed was responsible for the air purification and had taken this just before the accident occurred. It was then 2%. They had been submerged from 2 to 3 hours before the accident and the air purification plant had been switched off (to avoid noise during the attack).

From the time the flooding started until the hatch was opened was about 10 minutes. No one, as far as this man remembers, complained of the rapidly increasing pressure.

Out of the conning tower and control room 6 reached the surface and survived. Three without Draeger gear, three with it. It is of considerable interest that these three with Draeger gear were submerged completly for what must have been several minutes before they could come out of the conning tower. Of the original 50 survivors alive in the submarine after she sank, 14 survived. Of these 7 came up with no Draeger gear, 1 came up using the Draeger only as a lifebelt, with mouthpiece cock shut and the remainding 6 had Draeger gear. Six had survived from the control room and conning tower, 6 from the twill trunk hatch aft and two from the after hatch with no twill trunk at all.

NOTE: This survivor stated that the Draeger school has appreciated mixtures must be breathed at big depths (nitrogen and oxygen). The deeper the more accurate must be the mixture. He was asked if he felt he could come up from 300 ft. (if necessary) with no apparatus and replied Yes, provided he was only under pressure first for a very short time prior to the ascent.

U. S. S. TANG

The submarine sank after being hit by one of its own torpedoes circling

after an attack on the surface off Formosa in October 1944. She sank quickly by the stern and remained for 15 minutes at least at a very acute angle, the stern resting on the bottom, the bow sticking out of water. The upper C/T hatch was open as she sank; those in the C. R. managed to shut the lower C/T hatch, but it was strained by the explosion and leaked. The confusion at this stage with men and gear falling around, due to the acute angle, was great.

All but two of these in the conning tower were probably drowned almost at once. One of these, found himself breathing in a ring air pocket. He struggled out of this, and reached a larger pocket at the fore end of the C/T. These pockets were, of course, due to the acute angle. Very shortly after the accident, this officer ducked out from his air pocket and made a free ascent through the C/T hatch without breathing apparatus or lifebelt. This officer had been taught to exhale during a free ascent at the submarine school. He came up from 50-60 ft., and described his ascent as follows: "I began to swim up using both hands as hard as I could - the whole idea was to get up - I wanted air and lots of it I had no sensation of being under pressure, but thought about letting the air out and knew as I came up I would have to force the air out - So I heaved it out all at once - and then just as I thought I would have to swallow some salt water I burst out on the surface and began swimming" He was none the worse, had no pain in his chest, and swam around for about 8 hours before being picked up. The second man alive in the C/T was dazed and frightened. He was to have held on to the officer's trouser legs as he ducked out, but appears to have let go, and probably drowned without attempting to escape.

Meanwhile many men were alive (probably 45) in the C. R. and compartments forward, and in the E. R. and after Battery room. The compartments abaft the control room flooded fairly rapidly, and the men opened the door and got forward with the water already half up the door. Approximately 15-30 minutes after the accident, a rating in the control room opened a tank vent by hand, and the submarine sank to the bottom and levelled off without any very serious angle. The depth was now 180 ft. The men made their way forward until 45 of them (at least 2 with broken limbs and many others injured(were collected in the forward torpedo room. One of them, a negro, had had his face smashed in when the door into the forward torpedo room was opened. The emergency lights were working.

Not long after this an officer and some men tried to pass through the door aft, but as they cracked the door, dense smoke and fumes poured in through the door. This smoke was serious for some time. Men complained of irritation of throat and lungs and eyes, and "some seemed actually choking to death in it"; one survivor stated "this smoke did more to kill the men who didn't get out than any other thing". In twenty minutes or so, however, these conditions improved. There is little doubt that there was a bad battery fire in the forward battery room which continued right up to the end as the lower part of the bulkhead at the after end of the torpedo room got hotter and hotter until the paint began to peel. There had previously been another fire forward when the forward plane rigging and tilting motor burned out completely, lasting about 10 minutes.

There was probably a continously build-up of pressure from the flooded portion aft, as the escape proceeded, through some drains in the battery compartment via a sanitary tank and from this through drains into the torpedo room. This must have been assisted by the increase in pressure when men were admitted from the flooded part; by the fact that the explosion had fractured the airlines; and by the draining of the chamber into the compartment during the escape. Some survivors are said to have noticed the heightened pressure, but there is no definite evidence of it.

The first attempt was made about 4 hours after the accident, and the last escapee 6-7 hours after the accident; in all it is probable 5 attempts to escape were made. In the first attempt to escape four entered the escape compartment taking a rubber boat with them. There was a difference of opinion among them as to the drill, rigging and trunk, life line, etc; there was also some difficulty in getting this line out. One man didn't wait for the line and went out, this man had already been injured about the head in the first crash

and is reported to have used his lung and taken two pistols and a bayonet with him. He was not seen gain and whether he reached the surface or not is unknown. Some 40 minutes later as there was no signal from the trunk those inside drained it down. The three remaining must therefore have been under pressure equal to 180 feet for 40 minutes. The failure of these three men to escape after 40 minutes in the trunk must have discouraged those in the compartment especially as one of them stated he didn't care to attempt the escape again.

At the next attempt 5 went in, very much crowding the escape compartment, but the lifeboat was omitted. After another 40 minutes and no signal, those in the torpedo room drained the compartment and found 3 had gone up; one of these men had already been 40 minutes under pressure during the first escape. But 2 men remained: one was in a stupor, the other was very exhausted and had got forward of the life line which had pinned him to the trunk; the line was cut adrift and he was brought back into the submarine. Of the three who did escape, one survived, one was seen at the surface drifting away, and the third was never seen again.

The failure of these 2 and their exhausted condition together with the delay of 40 minutes must have still further discouraged those waiting to escape, as evidenced by survivors' statements - "after the first two attempts there were very few men who cared to try an escape although they knew what was going to happen to them below" - another states - "after 2 hours over half of the men did not care to attempt it". The rising partial pressure of CO2 and the smoke added naturally to their discouragement. For example a survivor states - " the constantly increasing pressure, smoke and heat seemed to effect everyone's thinking, after the difficulties of the first escape and the smoke all formed enthusiasm died down and many didn't care whether they escaped or not". (Apparently there was no panting, or difficulty in getting breath). To add to these terrible conditions the Japs were dropping depth charges from time to time".

A third party of one officer and three men then attempted the escape. Some difficulty was found in opening the door but this was soon overcome and the pressure was equalized by flooding, when the first man went to charge his lung from the oxygen manifold there was no oxygen, this greatly discouraged the other three. For about 15 minutes under the full pressure they attempted to rig a new lifeline, but the first man (the officer) who had blown up his lung from his own lungs began to feel dizzy, he stated as follows at this time:— "I felt very exhausted like I couldn't get any oxygen into my lungs I began to get dizzy so I knew I had better get out while I could, it took me about 15 minutes to rig the trunk and prepare the life line as a buoy. I would have let the ring go up to the surface and then gone up the line but I was so near passing out I went up with it. The other men could have escaped if they had only stepped out of the hatch, but they didn't want to try without oxygen although I explained how they could".

After this man got out he lost the mouthpiece of his lung about 20 feet from the submarine due to the men below jerking the line, he then made a free ascent, he states as follows:— "After 20 feet - I lost my lung, so I blew the air out all the way to the surface trying to equalize the escaping air the way the lung would have done, on reaching the surface I was exhausted and sick". He got to a life buoy, which another survivor had with him and was picked up about 3-4 hours later.

The fourth attempt was made by 4 men. One of these had already been in the trunk for 40 minutes under pressure and caught in the life line, another had also made a previous attempt. All these four escaped and probably reached the surface alive some 45 minutes after the previous men surfaced, although one of them disappeared soon and it isn't known what happened to him.

The last escape is very confused, and there may be more than one escape involved. Three men appear to have reached the surface, and all of them died. One had been apparently diving looking after the wounded man; he was nearly unconscious and had to be supported as his lung didn't give him

enough buoyancy. The survivor who held him up stated:— "He kept gasping as if he couldn't breathe and wouldn't understand anything. His condition grew worse until he stopped breathing.

The second man (a negro, possibly the man who had his face smashed) had no lung, and probably no lifeboat. His arms were seen flailing the water for a few seconds, and he was then seen floating away drowned.

Thethird man had a lung, and probably used it. He seemed very weak at first, but recovered after holding on to the buoy for some time. He talked to another survivor, and did not complain that anything was wrong with him. He was picked up by the Japanese, 1½ hours later, and thrown into a boat. He now began to froth at the mouth, and became blue, although he continued breathing for 10 minutes at least. He was then separated from the other survivors and never seen again.

Summarising these escapes: In the conning tower, there were 2 survivors, of whom one made a free ascent from 60 ft., and the other probably never attempted to escape. In the forward torpedo room there were 45 survivors, of whom probably 13 tried to escape 8 or 9 reached the surface, and 5 survived. One of the survivors made a free ascent without difficulty. Of these who died on the surface, one was probably already injured, one had been exposed to the pressure of 180 feet of water for a long time twice, and all had been subjected to rising pressure and smoke inside the submarine for several hours.

ADDENDUM

Note: The following accounts of U.S. Navy submarine disasters not due to enemy action are included for general information and interest although in no case were escapes in the usual sense attempted. (E.D.U., Aug. 1952)*

F-4 March 25, 1915. Failed to return from a submerged run off Honolulu. No survivors (21 lost); cause of disaster not determined although believed possible that acid-corroded hull-plates in battery compartment failed under pressure.

Located by means of oil-slick and air bubbles outside harbor, sunk in 305 ft. Raised Aug. 29, 1915.

Salvage work involved diving to that depth (previous record, 274 ft., 1914). Divers not intentionally kept on bottom more than 15 minutes, but one became fouled and spent about 2 hrs. at 250 ft. Nearly died of bends and subsequent bronchopneumonia but recovered.

F-1 1917. Rammed by F-3 in fog off Point Loma, Calif. Sank in 600 ft. 5 survivors (topside), 19 lost. No attempt at rescue or salvage.

S-5 1920. Sank during full-power trials off Delaware Capes. Water poured in through main induction on dive. Compartment valves were closed successfully except in forward room which was abandoned and hatch dogged.

Calculations indicated that stern could be brought to surface by blowing ballast and fuel tanks aft. About 80 tons of water which remained in the motor room bilges could not be pumped out due to failure of drain system. It was decided to allow this water to run forward as stern rose even though this involved flooding the battery compartment.

On blowing ballast aft, stern shot to surface cascading water, men, and equipment forward. In the resulting tumult, one man nearly drowned in the battery compartment but was fished out in time to permit dogging the hatch against the inevitable chlorine.

By tapping on the hull, it was found that stern was now 17 ft. out of water. Since no hatch was above the surface, an opening had to be made. After 36 hours of cutting, a 3 inch hole was made—through which it was possible to converse with the captain of a passing freighter who rowed over in a lifeboat to investigate.

*The above information was obtained from a variety of sources, among which should be mentioned:

(1) Barnes, R.H., United States Submarines, New Haven, H. F. Morse Associates, 1944.
(2) Davis, R.H., Deep Diving and Submarine Operations, London, The Saint Catherine Press, 1951.

2.

With outside assistance, the hole was enlarged; and the last man emerged 51 hours after the accident.

S-48 1921. Sank in 67 ft. off Bridgeport, Conn. during builders' trials. Manhole cover had been left off after ballast tank. Flooded steering-engine room, motor room, and engine room. Personnel were able to evacuate and shut the watertight door. By making light forward, the bow was raised above the surface and all escaped safely through a torpedo tube.

O-5 1923. Rammed and sunk off Atlantic entrance to Panama Canal. Three lives lost. Two men trapped in torpedo room were rescued when bow raised 31 hrs. later.

S-51 Sept. 25, 1925. Rammed by S.S. City of Rome off Block Island and sank in 132 ft. Three survivors apparently escaped through conning tower hatch as boat sank. 33 lost. Salvage efforts recounted in On the Bottom (Ellsberg).

S-4 Dec. 17, 1927. Collided with Coast Guard ship Paulding off Provincetown (Cape Cod), Mass. Sank rapidly in 102 ft.

Diver from U.S.S. Falcon on bottom 22 hrs. later identified tapping signals as coming from torpedo room where 6 men remained alive.

Storm rendered rescue efforts impossible, but communication by tapping on hull was continued between trapped men and surface vessels. Last message, 40 hrs. after sinking, indicated that the last oxygen cylinder was empty. Salvaged.

(Much of the impetus behind the developmental efforts which led to the submarine escape appliance and the submarine rescue chamber is said to have been due to the S-51 and S-4 disasters and the public outcry which followed).

O-9 1941. Lost off Portsmouth, N.H., with all hands. Cause not ascertained but believed related to fact that deep submergence tests were being conducted.

Located in 440 ft. Divers found evidence that hull had failed to withstand pressure; detected no sign of life aboard. Salvage not attempted.

3.

(The list of U.S. Navy submarine losses could be extended greatly if those due to enemy action were included. Several not in that category have also been omitted due to lack of information or because no connection with escape or diving was apparent).

An early example of successful Free Escape, of historical interest, is found on page 3 of reference (1). The account is quoted directly:

"In 1860, a German by the name of Bauer built a hand-propelled submarine of considerable success. Several underwater runs were made. Later, in 1863, with two companions to assist him, Bauer made a dive in 50 ft. of water in the Kiel Canal. On getting below the surface, the submarine became heavy and sank out of control to the bottom. All attempts to raise her failed. Bauer then decided to force the hatch open by flooding the submarine, thus giving them a chance to escape and swim to safety. His companions demurred. Finally, after mush persuasion on the part of Bauer, and the fact that the good air was running short, they consented. The submarine was flooded, the hatch came open, and all three escaped without injury to the surface. Many years later, Bauer's submarine was discovered and brought to the surface during dredging operations. Bauer built a second submarine which was an improvement over the one he lost."